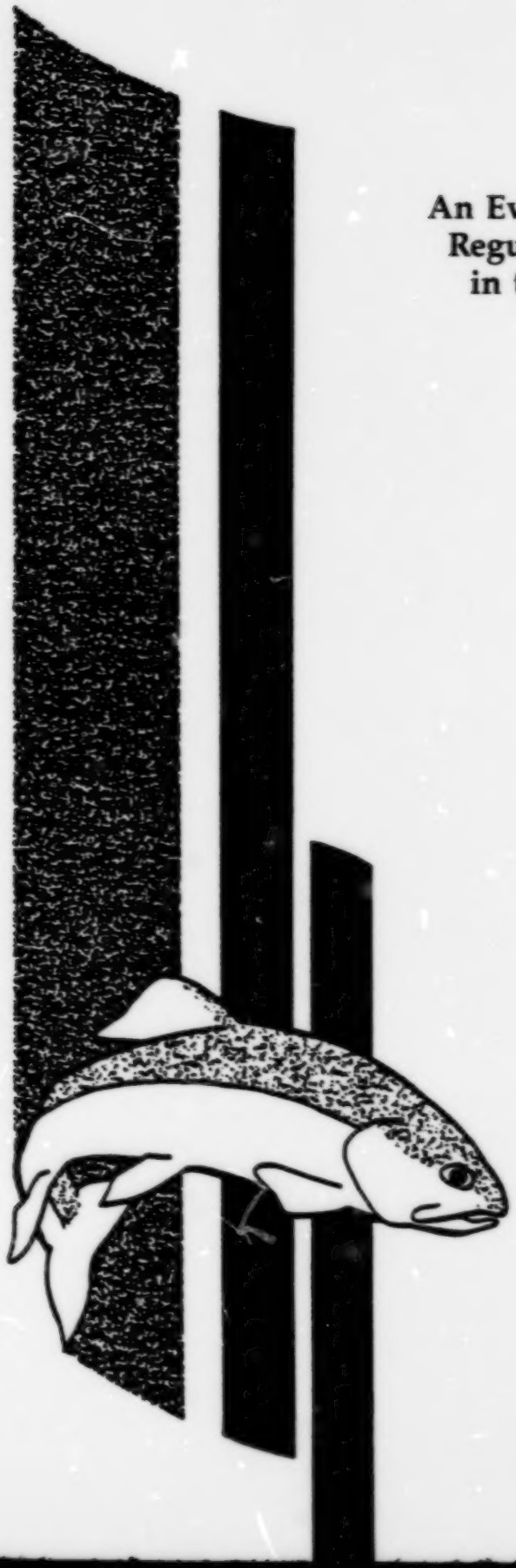

An Evaluation of Special Angling Regulations for Cutthroat Trout in the Lower St. Mary River

by

G.G. OLIVER

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ABSTRACT

Annual studies of wild westslope cutthroat trout (Oncorhynchus clarki lewisi) were conducted at the lower St. Mary River in the East Kootenay for a ten year period from 1980 to 1990. The effects of progressive fishery regulation changes on the population were examined by underwater surveys and standardized angling techniques. Age and growth characteristics of the cutthroat population were also documented. After pollution abatement in the late 1970's, the lower river supported a largely unexploited fluvial trout population (adult spawning and juvenile rearing in tributaries; adult rearing in the mainstem river) with a mean length of 342 mm and a range from 260 to 440 mm. Estimated trout abundance was 118 per km of stream channel. Angling regulations in 1980/81 included catch and possession limits of 4 fish and a 'flyfishing' only restriction for approximately 18.5 km. In 1982, the total estimated population was 6400 cutthroat trout >20 cm. From 1984 to 1990, population trends were monitored using a 3.3 km "index section" of the river. In the presence of an expanding fishery, numbers of catchable wild fish declined from a peak of 96 per km in 1986 to 47 per km in 1990. Despite further restrictive regulations including a 2 fish catch limit, a bait ban, a winter trout closure and a 30 cm minimum size limit, the estimated population in 1989 was 2921 fish and mean size had dropped to 271 mm, in contrast to 342 mm 7-8 years earlier. An experimental shift in 1988 to a catch and release regulation on a 13 km section of river resulted in an increase in the proportion of larger fish after a single year although further sampling and counts are needed to confirm this improvement. Only 34% of the population exceeded 300 mm in the section with a kill fishery, but in contrast 51% of the population were >300 mm within the trout release section, although with the small size (n=4,2) a difference could not be statistically confirmed. A comparison of counts in a 4 km catch and release "index site" after two years however, indicated a significant difference as the percentage of trout >300 mm increased from 18% (prior) to 33% after regulation. Future intensive management options to improve the age structure, and thereby fishery quality, in the kill zone include catch-and-release or an increased minimum size limit of 35 cm. The latter would permit a small harvest of trophy fish and diversify the fishery.

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INTRODUCTION

The implementation of special or restrictive angling regulations on highly accessible resident stream fisheries have been encouraged to prevent over-exploitation of wild native stocks or loss of quality size fish. Several accounts of improved angling opportunities have been reported in the western U.S. and Alberta (Johnson and Bjornn 1975; Thurow and Bjornn 1978; Vincent 1980; Anderson and Nehring 1984; Rhude 1987). These studies demonstrate the importance and success of special regulations in managing these types of sport fisheries on rivers elsewhere. In British Columbia, there have been no published studies on the effects of restrictive regulations on resident trout populations other than the fishery closures (cutthroat, Martin 1983, Martin and Bell 1984; rainbow, Slaney 1987). Special regulations are designed to maintain a quality stream fishery based on management objectives that include an acceptable standing stock, catch rate and fish size (Slaney et al. 1984). These are particularly important considerations for stream populations that exhibit relatively low productivity (i.e. slow growth and low recruitment) and high angler pressure.

During the 1980's, restrictive angling regulations were implemented on several East Kootenay cutthroat trout streams to promote quality stream fisheries. The lower St. Mary River is one example where more restrictive regulations were implemented to sustain a quality wild cutthroat trout fishery. Catch and possession quotas of 8 and 24, respectively, were very liberal throughout the Kootenay Region as late as 1979. In 1980, catch and possession limits on the St. Mary River were reduced to 4 and a 'flyfishing only' section was designated for 18.5 km from Mark to Joseph Creeks (Fig. 1). In 1982, this designation was amended to include the entire river downstream of St. Mary Lake, and a 30 cm minimum size limit was implemented. In 1983, catch and possession limits were further reduced to 2 and 4, respectively. By 1984, a seasonal closure for trout from November 1 to June 14 and a bait ban from June 15 to October 31 were invoked. Finally, in 1988, the 13 km section from Mark Creek to the McPhee Bridge was designated 'catch and release' for trout. Angler activity was extremely low up to 1980, because of mining effluent. Since then, angler effort has increased steadily to about 3000 angler days which was grossly estimated from frequent observations and comparisons to other rivers where creel census have been conducted.

Investigations on the status of the westslope cutthroat trout population (O. clarki lewisi) in the lower St. Mary River have been conducted since 1980 following pollution abatement of effluent discharges in 1979 from Cominco's Sullivan Mine in Kimberley. In 1980 to 1981, the size and age distribution of the population were determined and in 1982, representative sections in seven distinct reaches of the lower river were surveyed to provide an estimate of the trout population. From 1984 to 1990, a 3.3 km 'index section' of river was assessed to provide trend information on population structure and status following the progressive implementation of restrictive regulations. A population estimate was again repeated in 1989 for comparison with the 1982 survey.

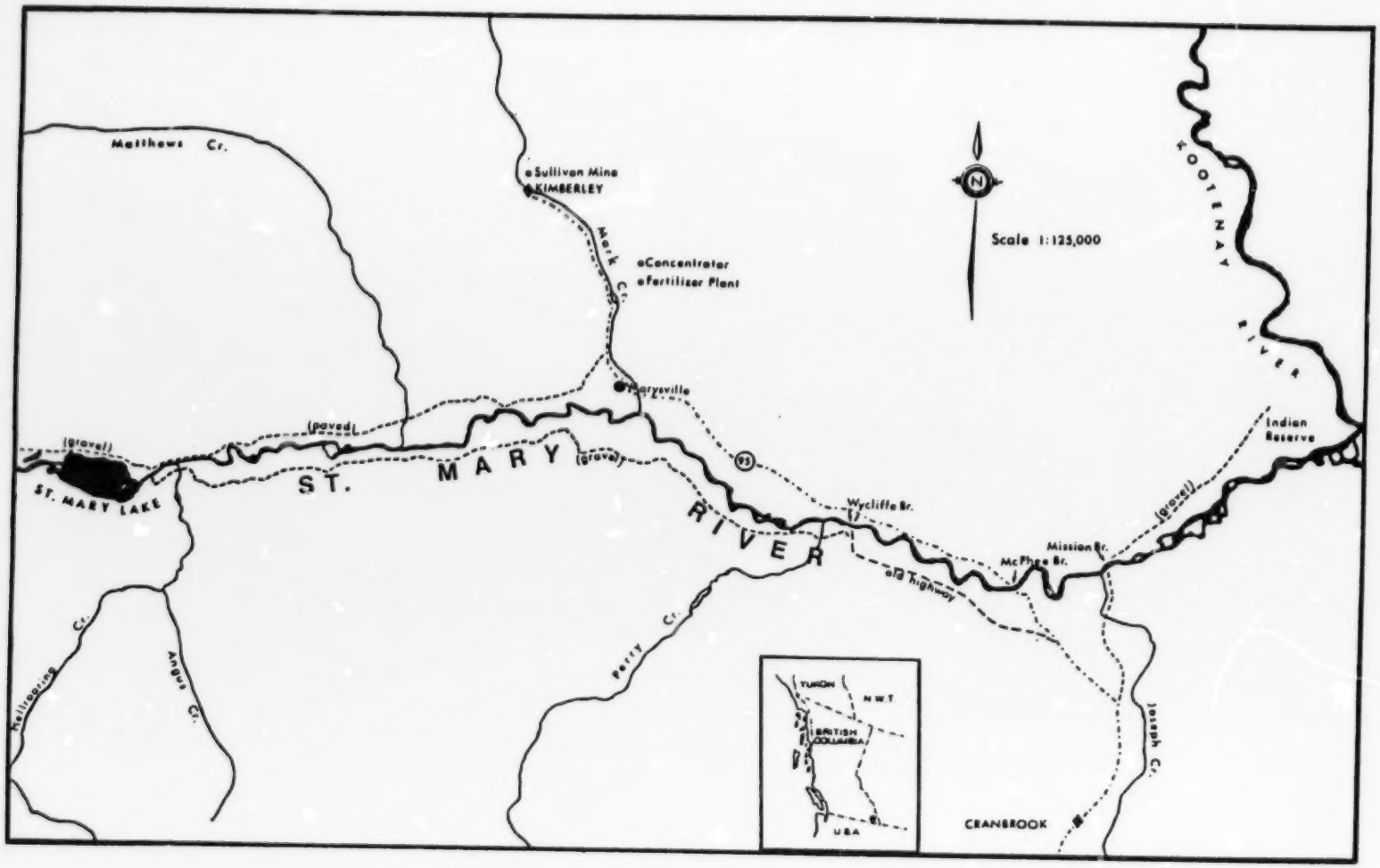

Figure 1. Location of study area and tributary streams of the lower St. Mary River.

This report summarizes the status of the cutthroat population in the lower river since 1980 and evaluates the importance of special regulations in maintaining a wild trout population, comprised of quality-sized fish.

METHODS

Study Area

The St. Mary River is located in southeastern British Columbia, where it originates in the Purcell Mountains and flows east joining the Kootenay River in the Southern Rocky Mountain Trench near Fort Steele (Fig. 1). The upper and lower rivers are separated by St. Mary Lake. The upper river lies within the Interior Western Hemlock biogeoclimatic zone while the lower one occupies the Interior Douglas Fir biogeoclimatic zone (Krajina 1969).

The annual hydrograph is typical of most interior streams where flows are dominated by spring snowmelt (Fig. 2). Maximum flows usually occur in June (mean 221 m^3/s) and mean annual discharge is approximately 52.7 m^3/s (Anon. 1988). Flow is largely controlled by the amount of annual snowpack although rain storms during spring and late summer often cause isolated peaks. During winter, some anchor ice occurs from December to February.

Indices of stream productivity are low to moderate. Mean annual TDS is 45 mg/l (data on file; Environmental Protection Branch). Average dissolved NO_3-N and SRP concentrations are moderately high during late summer-winter: concentrations are 0.14 and 0.005 mg/l respectively in recent years (data on file; B.C. Fisheries Branch). Ortho-phosphate levels were about 2 orders of magnitude higher in the mid-1970's (Table 1). Until closure of the Cominco fertilizer plant in 1989, periodic fluctuations in nutrient level above background concentrations were recorded throughout the 1980's (refer to Table 1). Although nitrate-nitrogen concentration is high compared to other streams, the lower river was described as nitrogen limited in 1984 (McDonald 1985), but recent determinations indicate phosphorus provides the primary limitation to production.

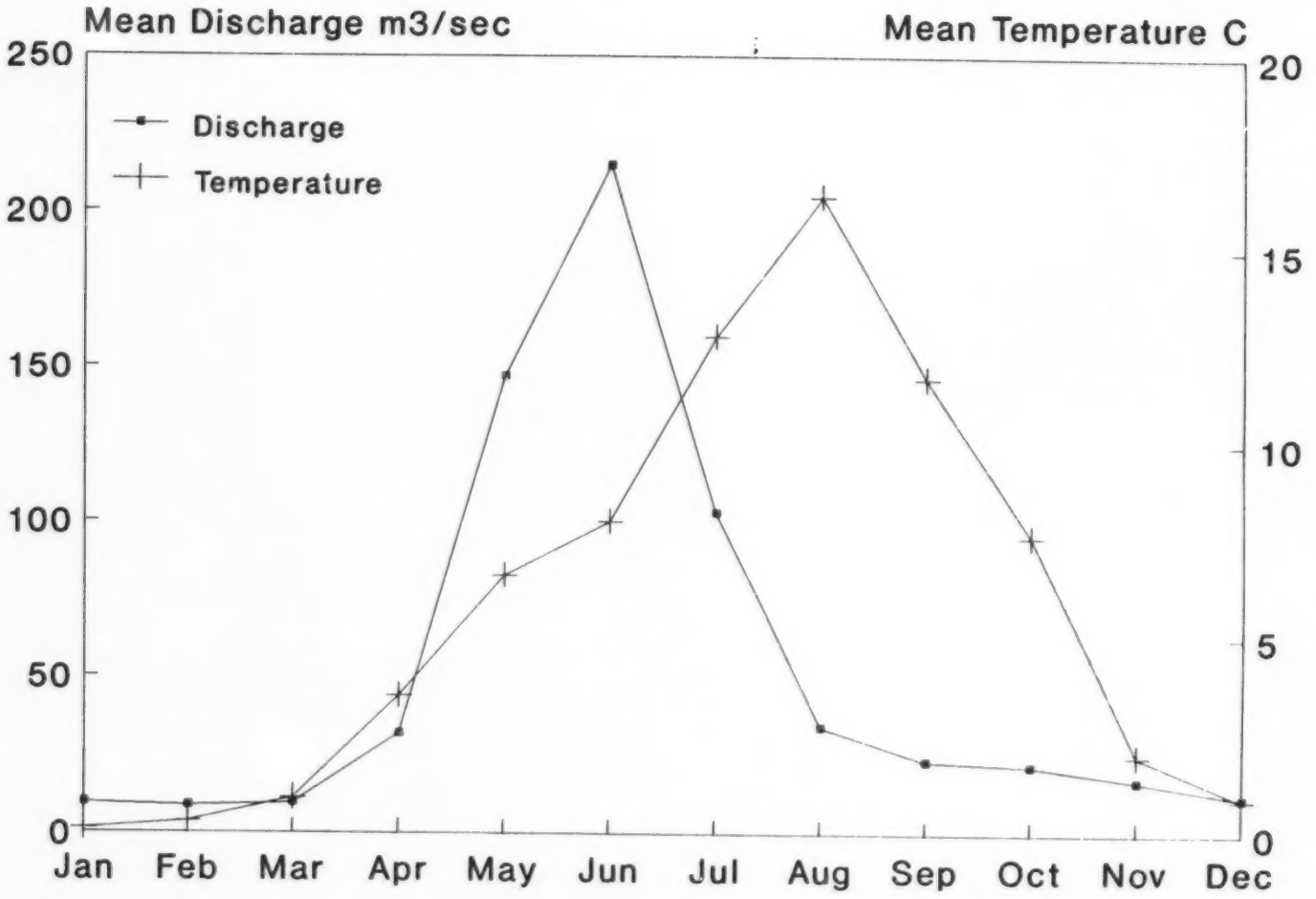

Figure 2. Discharge and water temperature of the lower St. Mary River.

Table 1. Selected levels of dissolved nitrate-nitrogen and orthophosphate (mg/l) during low flow of late summer or late winter (1987-89) in the lower St. Mary River from 1975 to 1985 (file data, Environmental Protection Branch).

Date	Above Kimberley		Below Kimberley (5.5 km D/S)	
	NO_3-N (mg/l)	SRP (mg/l)	NO_3-N (mg/l)	SRP (mg/l)
Sept 11/75	0.06	<0.003	0.10	0.530
Sept 14/76	0.06	<0.003	0.07	0.008
Aug 15/78	0.05	<0.003	0.07	0.004
Oct 29/79	0.06	<0.003	0.13	0.171
Mar 17/80	0.16	<0.003	0.31	0.110
Sept 25/85	0.05	<0.003	0.13	0.171
Mar 19/87	0.13	<0.003	0.25	0.051
Mar 9/88	0.15	<0.003	0.43	0.003
Mar 21/89	0.16	<0.003	0.29	0.003

Mean monthly water temperature (Fig. 2) ranges from a low of 0.1 C in January to a high of 16.4 C in August. Mean summer temperature (June 15 to September 30) is 12 C.

The river downstream of St. Mary Lake is typical of long riffle and glide-run sequences dominated by boulder. The single channel is bounded by river terraces over most of its course. Bed materials include gravel, rubble, boulder and infrequent bedrock outcrops. The amount of in-stream LOD is limited. There are five major tributaries in the lower river; Hellroaring, Mathew, Mark, Perry and Joseph Creeks. With the exception of Joseph Creek, the tributaries are steep, cool and relatively unproductive.

Water quality in the St. Mary River downstream of Kimberley was impaired during the 1960's and early 1970's as a result of both acid mine drainage and fertilizer plant effluent. During periods of low flow, the effluent was highly acidic and had extremely high levels of dissolved fluoride, ammonia,

phosphate and heavy metals (Anon 1981). Extremely toxic conditions in 1960 to 1970 were documented including the complete absence of macro-invertebrate and fish production (Bull et al 1969, Whately 1969, Crozier 1973, Anon 1976). Angling opportunities were eliminated in the St. Mary River for 42 km downstream of Kimberley and in Mark Creek (Sinclair 1966).

In 1975, recycling and treatment of tailings effluent was instituted. By 1979, Cominco had completed and made operational a waste water treatment plant improving water quality in the river. Benthic invertebrate densities increased dramatically from 1976 to 1977 and several species of fish began to recolonize formerly barren habitat (Anon 1977). By 1982, cutthroat trout, brook trout, bull trout, mountain whitefish, burbot and rainbow trout utilized the lower river downstream of Kimberley. Nutrient concentrations have gradually declined to moderate levels but this has probably been offset by improvements in other water quality parameters.

Fish Sampling

Cutthroat trout were aged using scales sampled within 3-5 rows above the lateral line immediately behind the dorsal fin. They were cleaned, mounted and read with a microprojector (Microcom 1600 Microfiche Reader). Measurements of scale radius and distance to each annulus were marked on a paper strip, body/scale relationship determined by regression analysis and length at successive annuli back-calculated using Lea's Formula (Bagenal 1978). Juvenile growth in tributaries was interpreted from scales by examining the spacing pattern of annuli. The number of tightly spaced annuli up to the first period of large incremental growth was interpreted to represent the number of years of juvenile growth in a tributary environment. Fish samples were obtained from the St. Mary River by angling techniques.

Population Census

Population estimates of cutthroat trout conducted in August 1982 were obtained by underwater census. Twelve representative sample sites consisting of 6 riffle and 6 glide-run habitat units were selected within seven reaches, some of which formed differing regulation zones later (Fig. 3). Deep pools were excluded because they are rare compared to the other habitat units. Numerical counts of cutthroat trout were grouped into three size categories, estimated visually: juvenile (<200 mm), sub-adult (200-300 mm) and adult (>300 mm), recorded during two passes over the cross-sectional area of the sample site using two observers. Counts were initiated within 6 m of each shore moving to mid-channel zones on the second pass. Additional passes were made, if necessary, to ensure that the entire wetted perimeter was enumerated or to obtain a reliable estimate. The

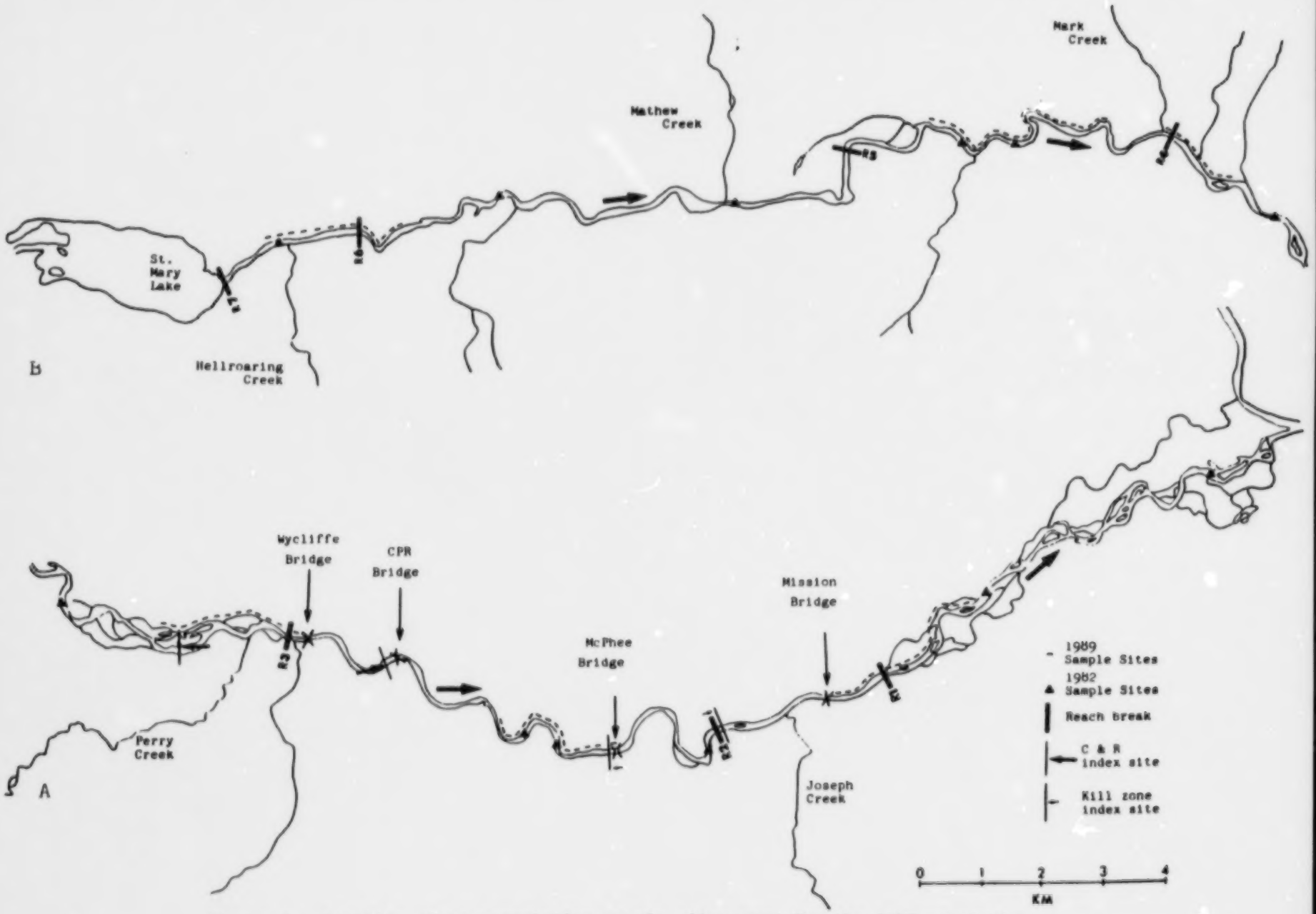

Figure 3. Location of representative sample sites used for the 1982 population estimate and index site locations (A, lower river; B, upper river).

length of sample sites of riffle habitat averaged 117 m (range 22-300 m) and glide-run habitat sample sites averaged 67 m (range 20-99 m). The lineal distance of each habitat unit was determined for the reach. The counts for riffle and glide-run complexes were then multiplied by the total distance of each habitat type per reach and summed to provide an expanded estimate of the lower river population.

The underwater census was repeated in September 1989 following a similar method to Slaney and Martin (1987). Cutthroat trout were visually grouped in size categories from 100-199, 200-299, 300-399 and 400+ mm. Six sites ranging from 1.7 to 3.5 km in length were selected (Fig. 3). However, they were enumerated without replication using four counting lanes (two shore and two near-shore). The central lanes were excluded because of low counts obtained from two initial passes that confirmed a more lateral distribution of fish as a consequence of the higher stage of flow (wetted width approximately 12 m greater in 1989 than previous years). Thus a minimum population estimate for the lower river was obtained by multiplying the mean count from the 6 sample sites by the lineal distance of the river. Mean counts were expanded by using a correction factor of 1.35 as determined by Slaney and Martin (1987).

Population trends from 1984 to 1990 from McPhee Bridge to a point 3.3 km downstream (Fig.3) were estimated using 5 to 7 counting lanes stratified into shore, near-shore and mid-channel zones as in Slaney and Martin (1987). All counts were made during late August to early September. With the exception of the 1989 estimate, counts were replicated each year. Slaney and Martin found that a single count was lower than subsequent replicates. Thus, unreplicated counts are minimal estimates. Trend estimates from 1984-90 are relative differences only; absolute values require application of a correction factor.

Population estimates were also conducted in a 4 km section of river within the trout release zone in August 1988 and again in August 1990 (catch and release index site, Fig.3). In 1988, three counting lanes stratified into shore, near-shore and mid-channel were employed. In 1990, five stratified counting lanes (2 shore, 2 near-shore and 1 mid-channel) were used. In each year all counts were replicated. In each case, expansions were made following the same methods as Slaney and Martin (1987).

RESULTS

Age and Growth

Annual size increments were 61 mm, 68 mm, 113 mm and 65 mm from age 1 to 4 respectively (Table 2). The body-scale relationship was described by the equation (n=22)

$$y = 11.85 + .25\ (x)\ (r^2 = 0.56).$$

Interpretation of tributary residence derived by scale interpretation indicated that these fish typically spent 2 years in nursery streams prior to emigration. There were two years of slow growth followed by rapid growth in the third year, although a greater sample size is required to characterize life history patterns.

Table 2. Back-calculated mean length (mm) at age of cutthroat trout from the lower St. Mary River in 1980. (±1 SE; in parenthesis).

Age	n	Stream Growth (yr)	Mean Length at Age (yr) I	II	III	IV
2+	7	2	62 (1.29)	137 (2.93)		
3+	9	2	57 (1.56)	121 (1.73)	234 (2.01)	
4+	6	2	63 (1.29)	130 (2.28)	249 (2.79)	307 (1.82)
Grand mean			61	129	242	307

Population Assessment

In 1982, a total of 6,405 fish >20 cm were estimated within 54.1 km of the lower St. Mary River (Table 3). Of the 3,367 fish occupying glide-run habitat, 67% on average were >300 mm. Similarly, of 3,038 fish occupying riffle habitat, 63% on average were >300 mm FL. Smaller fish were abundant only in Reach 5 (25% >300 mm).

In contrast, a total of 2,921 or 46% cutthroat trout were estimated to inhabit the same distance in 1989 (Table 4). Of the six sample sites (ranging from 1.7 to 3.5 km in length) used to estimate abundance, two were located within the trout release section while four sites were located in the kill fishery section. After seven years, only 34% on average (mean 17/km; 1

Table 3. Expanded counts of cutthroat trout per habitat unit in the lower St. Mary River in 1982.

Sample Site	Total Length of Habitat Unit Per Reach (km)	Average Width (m)	Total Fish 200-300 mm	Total Fish >300 mm	Total Fish %>300 mm
		Glide-run Habitat			
1	8.7	32	47	59	55
2	2.2	46	0	142	100
3	6.4	38	50	50	50
4	5.2	43	22	89	80
5	2.3	32	83	27	25
6	5.0	36	20	91	82
7	limited glide habitat				
Total	29.8				
Mean/site		37.8	37	76	67
Total fish			1103	2264	
Combined total			3367		
		Riffle Habitat			
1	limited riffle habitat				
2	1.1	32	56	312	70
3	5.8	35	50	200	80
4	3.8	43	0	42	100
5	5.0	32	134	45	25
6	6.4	20	10	10	50
7	2.2	35	30	37	55
Total	24.3				
Mean/site		33.5	47	78	63
Total fish			1142	1895	
Comb. total	54.1		3038		
Grand total			6405		

Table 4. Expanded counts of cutthroat trout from six sample sites in the lower St. Mary River during 1989

Sample Site	Total Length (km)	Average Width (m)	Total No. Fish	Fish/km	No. of Fish >300 mm	%>300 mm
1	3.5	44	218	62	20	32
2	3.2	47	136	43	15	34
3	2.9	52	187	65	27	42
4	1.7	48	58	34	20	59
5	3.3	47	210	63	21	33
6	2.0	47	81	39	14	36
Mean	2.6	47.3	148	54	20	34[1]
						51[2]

Total River Distance 54.1 km

Total Fish 2921

[1] Kill Zone; [2] Catch and Release Zone (sites 3 and 4)

SE = 2.1) of the population in the kill fishery were >300 mm. In the trout release zone (sites 3 and 4) an average of 51% (mean 24/km; 1 SE = 3.6) of the population exceeded 300 mm but there was not a statistically significant difference because of the low sample size (t-test;$p > .05$,n=4,2).

There were significant changes however, in the numbers and size of the trout population in the kill and catch and release index zones. There was about a 50% decline in the number of cutthroat trout >200 mm within the kill zone from 1984 to 1990 (Fig. 4). The population of trout in this 3.3 km section decreased from a peak of 308 trout in 1986 to 150 in 1990, or from 96/km to 47/km (chi-square; $p < .05$). Also, the size distribution of trout changed over the seven year period. A reduction of the larger trout was evident, mean size declining from 342 mm in 1981 to 271 mm in 1989 (Fig. 5). There was an improvement in size distribution in the catch and release index site because the percent of fish >300 mm increased from 18 to 33% after two years following the introduction of the catch and release regulation in 1988 (chi-square; $p < .05$; Table 5) and the difference was statistically significant.

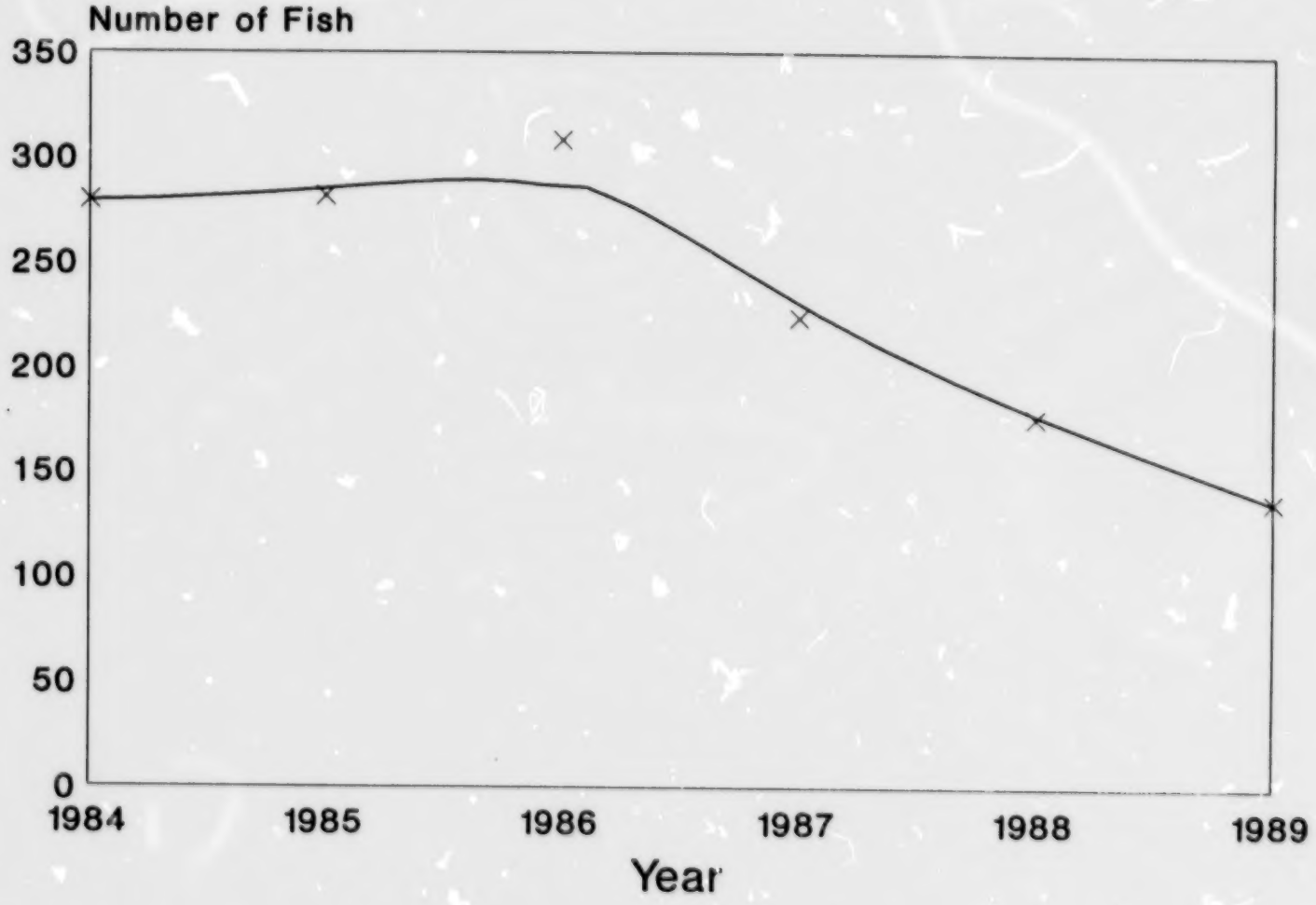

Figure 4. Population trend from 1984 to 1990 at the kill fishery index site of the lower St. Mary River.

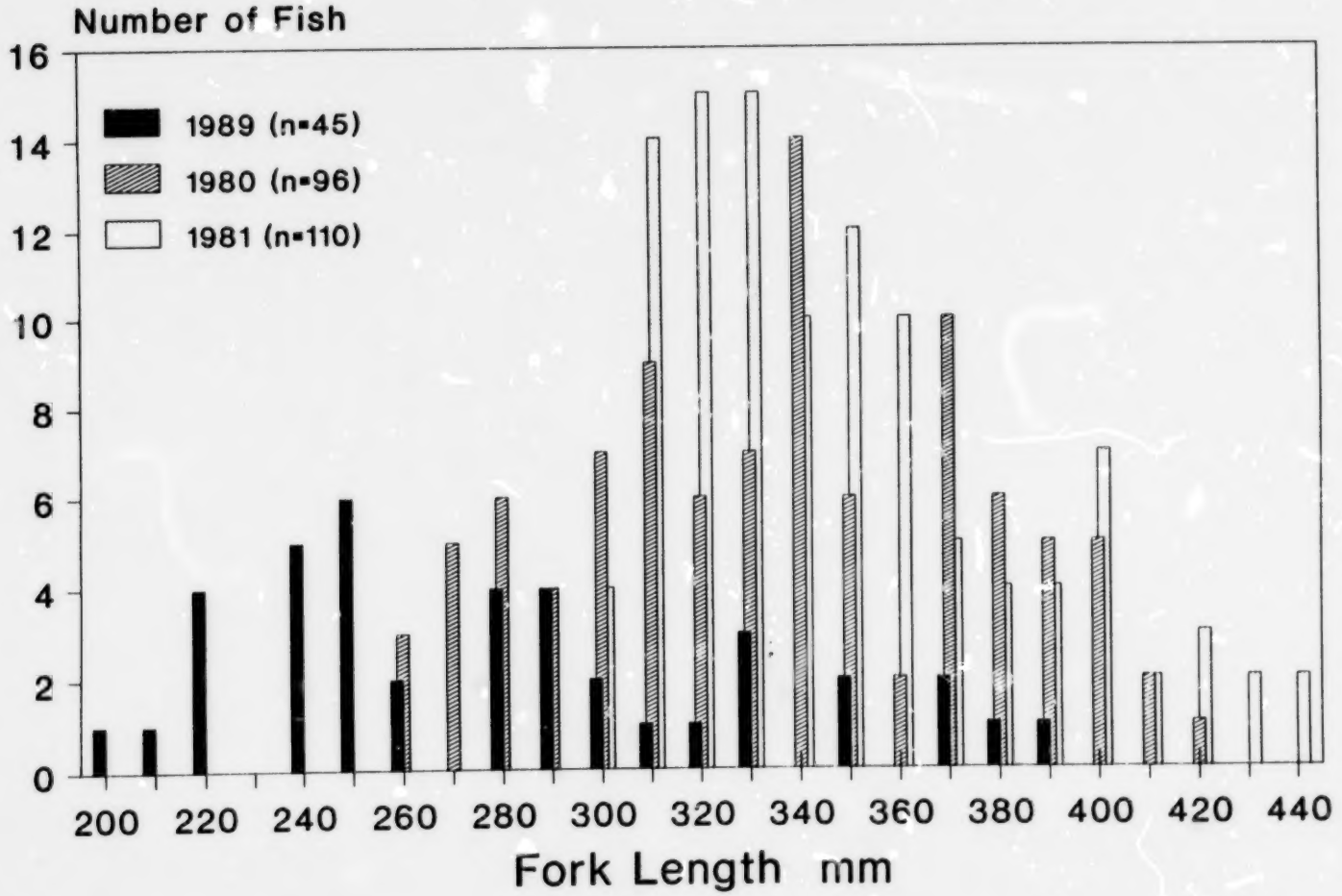

Figure 5. Length frequency distribution of cutthroat trout in the lower St. Mary River during three years (1980, 1981, and 1989; samples were collected by angling techniques).

Table 5. Mean expanded counts of cutthroat trout in the Catch and Release index site in 1988(pre) and 1990(post) (percent composition in parenthesis).

Year	Average Width (m)	Total Fish	Number of fish/size group 100-199 mm	200-299 mm	300-399 mm	>400 mm	Percent >300 mm
1988	33.4	265	52 (19.7)	166 (62.6)	43 (16.2)	4 (1.5)	18
1990	46.1	176	18 (10.2)	100 (56.8)	52 (29.6)	6 (3.4)	33

DISCUSSION

Despite the paucity of angler use statistics for the lower St. Mary River cutthroat trout fishery, effort has increased dramatically since 1980. At the inception of this study, the lower river was still perceived by local anglers as being 'polluted' and angler use was virtually non-existent. Based on estimates of surveys conducted at the upper St. Mary River (Martin and Bell 1984) and the Elk River (Martin 1983) where angler effort ranged from 46 to 112 angler days/km of stream, respectively, the lower St. Mary River probably supports 55 days/km or approximately 3000 angler days at present. Thus, monitoring of the cutthroat population over the last decade provides an unique example of the change in status and age structure of a wild population under the influence of gradualllly increasing angling pressure. Also, this study suggests a positive response of a trout population, within a low to moderately productive stream environment, to catch and release angling regulations. In view of the current population status, existing regulations in the kill zone have not been restrictive enough to ensure the population is near capacity with a significant percentage of larger or "quality" trout.

Differences in population estimates between 1982 and 1989 are likely influenced by the two different assessment methods as well as differences in stage of flow (mean width was 36 m in 1982 and 47 m in 1989; data on file). In 1982, population estimates for individual habitat units were fewer in number compared to those enumerated in 1989. Expanded counts may therefore be in error if sample sites are not truly representative. The results of the 1989 census can be challenged on the basis of incomplete stratification across the width of the river. Regardless, the two shore and near-shore lanes were selected to compensate for increases in flow

(~12 m difference in wetted width between the two census periods). Cutthroat distribution tends to shift towards shore as flow increases (data on file; B.C. Fisheries Branch). A single replicated count comparing stratified versus shore and near-shore lanes at the onset of the 1989 study, indicated that stratified counts with four counting lanes, in fact, over-estimated near-shore lane counts by about 10% and mid-channel lane counts by about 50% after expansion. Further comparison of estimates from the 1989 and 1990 index site in the kill zone suggest that the estimates are acceptable (136 vs 150). The 1990 estimate is considered to be most accurate because five counting lanes were utilized permitting stratification, and also the counts were replicated (Slaney and Martin 1987).

Even though differences in sampling methodologies may explain some of the variation in population assessments between 1982 and 1989, significantly lower numbers of fish were estimated during the last census. Also, a >40% reduction in the cutthroat trout population since 1982 has resulted in a shift in the age structure toward younger fish. This was reflected by the reduction in mean size from 342 mm in 1981 to 271 mm in 1989.

A change in the nutrient status of the lower St. Mary River may also explain some of the variation in trout abundance. Although significant reductions in effluent from the fertilizer plant were observed after 1975, elevated nutrient levels during the early 1980's may have sustained the trout population at an artificial number. With a return to more natural conditions by 1989, the decline in the population may have partially reflected changes in trophic status.

An imbalance in the age structure of the population, particularly evident during the early 1980's suggests that low recruitment may also influence the overall population structure. Recent assessments of tributaries have shown juvenile abundances to be lower than density estimates based on stream capability (data on file; B.C. Fisheries Branch). Therefore, a recruitment problem may be partially responsible for changes in population status as well.

While factors including declining nutrient, changing habitat and juvenile recruitment cannot be discounted, it appears that existing regulations, under increasing levels of use since 1986, have not kept the population at or near capacity with the desired age structure. In accordance with a management strategy promoting quality stream fisheries in the East Kootenay (Oliver, 1989), additional restrictions in the kill fishery are warranted. An increase in the minimum size to 35 cm would likely improve the age structure of that portion of the population contributing to the kill fishery.

Catch and release angling has shown some promise two years following its implementation to diversify angling opportunities. An increase in the percentage of older individuals will not only provide the type of quality experience sought after by many anglers, but serve as a refuge for spawners beyond the first year of maturity. A comparison of the size

structure of the population at sites within and outside of the trout release boundary in 1989 suggested a larger proportion of adult fish >300 mm (51% vs 34%, respectively) in the catch and release zone. A statistically significant improvement in mean size of cutthroat trout in the catch and release index site was also indicated; the percentage of adult fish >300 mm almost doubled over the two year period. However, additional replicate years of counting and fish sampling are needed to confirm this difference exists. The lower population estimate of 176 in 1990 vs 265 in 1988 was probably affected by differences in enumeration methods (3 counting lanes in 1988 versus 4 in 1990). A difference of 13 m in wetted perimeter between sampling periods could also affect fish distribution and hence stratified counts in 1988 probably inflated the population estimate after expansion. This estimate however, would not be expected to effect the size distribution of fish. Therefore these results suggest that trout release sections should be effective on those streams characteristic of low to moderate productivities with high species catchability and relatively high levels of angler use.

Future monitoring of the fish populations at the index sites should utilize a minimum of 5 observers where wetted widths exceed 35 m. Complete stratification into 2 shore, 2 near-shore and 1 mid-channel lane will compensate for fish distribution at higher flows and improve upon the accuracy of the population estimate. Creel surveys should be conducted in future to determine actual angler effort on the lower St. Mary River. Catch and effort statistics are required to determine whether or not present regulations will maintain a quality fishery. Should these statistics indicate otherwise, an increase in the minimum size limit to 35 cm is recommended for the kill fishery. Alternatively, an increase in the length of the trout release section would provide adequate protection. Restrictive regulations of this nature are considered essential in maintaining a balanced age structure in naturally supported stream populations subject to significant fishing pressure.

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